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Knepler et al.

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(54) **BEVERAGE COMMUNICATIONS SYSTEM USING A COMMUNICATION PROTOCOL**

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H04W 4/70 (2018.01)
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CPC ***G07F 13/065*** (2013.01); ***G06Q 50/12*** (2013.01); ***G07F 9/02*** (2013.01); ***H04W 4/70*** (2018.02)

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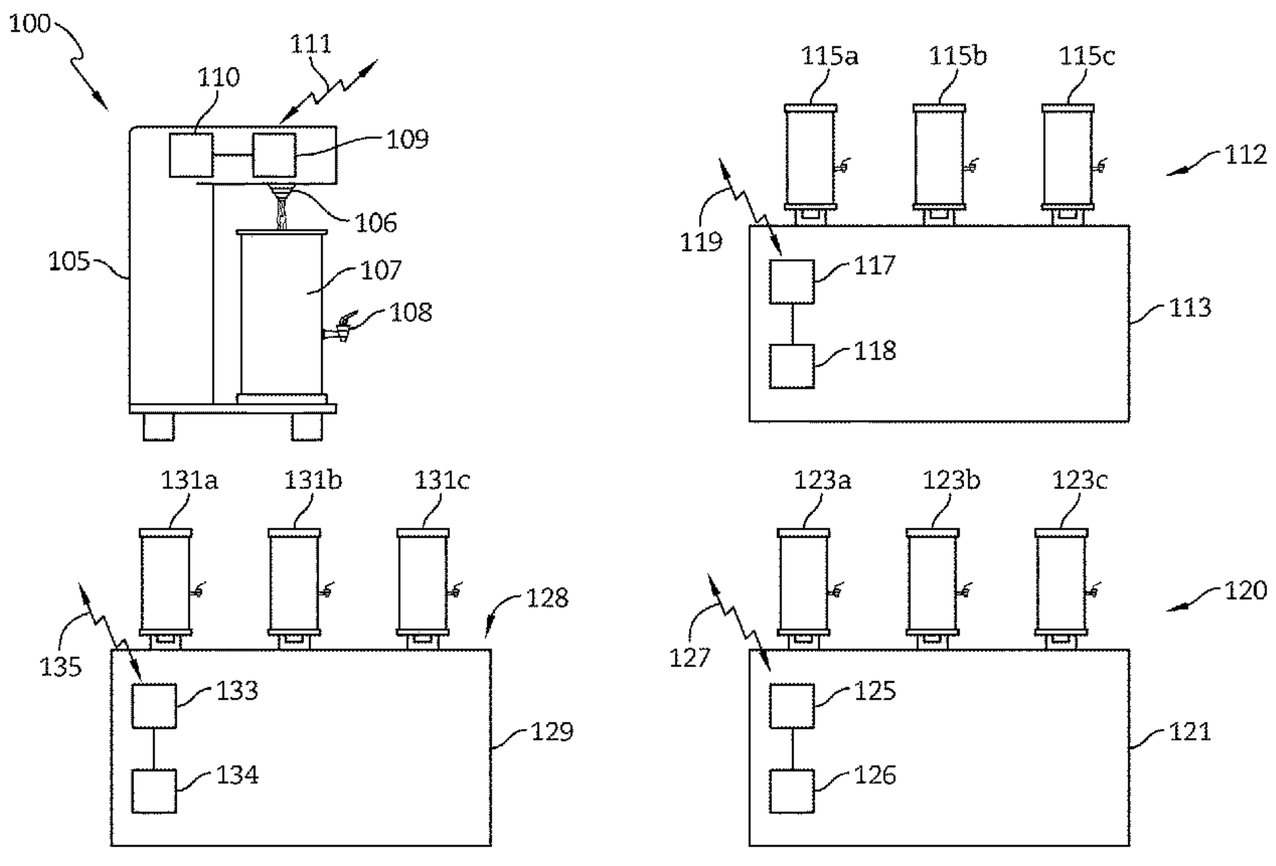
(57) **ABSTRACT**

A beverage communication network having a brewer, stands, and servers atop the stands, in which the brewer and the stands communicate in accordance with a suitable wired or wireless communication protocol, such as Bluetooth® Low Energy. The brewer can monitor the status of the servers, including the freshness and temperature of the beverage contained within the servers, the equipment status of the servers, and communication signal quality in the network. The status of the servers can be displayed to an on-site user through a tablet computer coupled to the brewer or to a remote user through a computer connected to the Internet.

13 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

G07F 9/02	(2006.01)
G06Q 50/12	(2012.01)
H05B 6/00	(2006.01)
A47J 31/047	(2006.01)

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USPC 705/15
See application file for complete search history.

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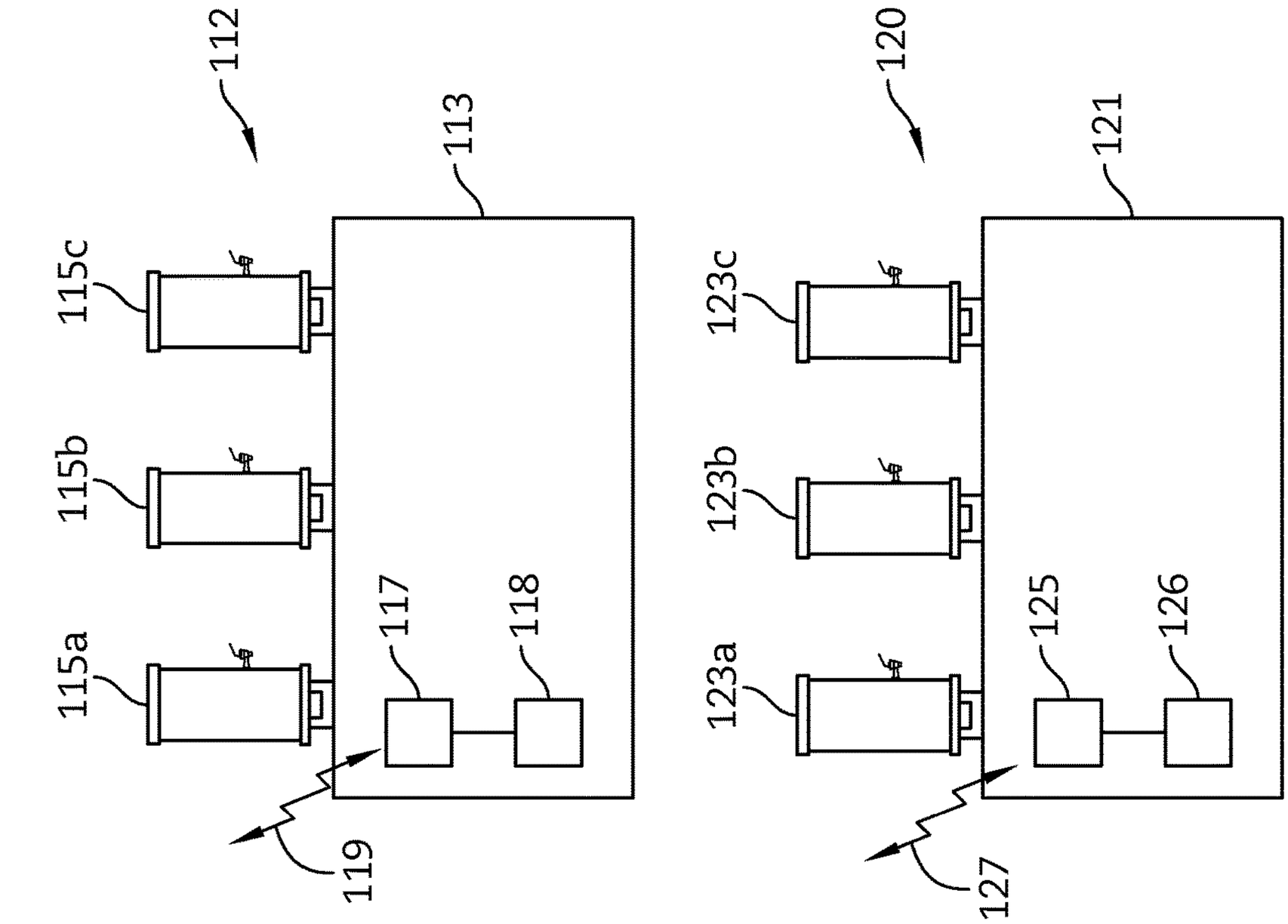
112
113
115c
115b
115a
117
118
119
120
121
123c
123b
123a
125
126
127
128
129
131c
131b
131a
133
134
135
100
109
106
107
108
111
110
105

FIG. 1

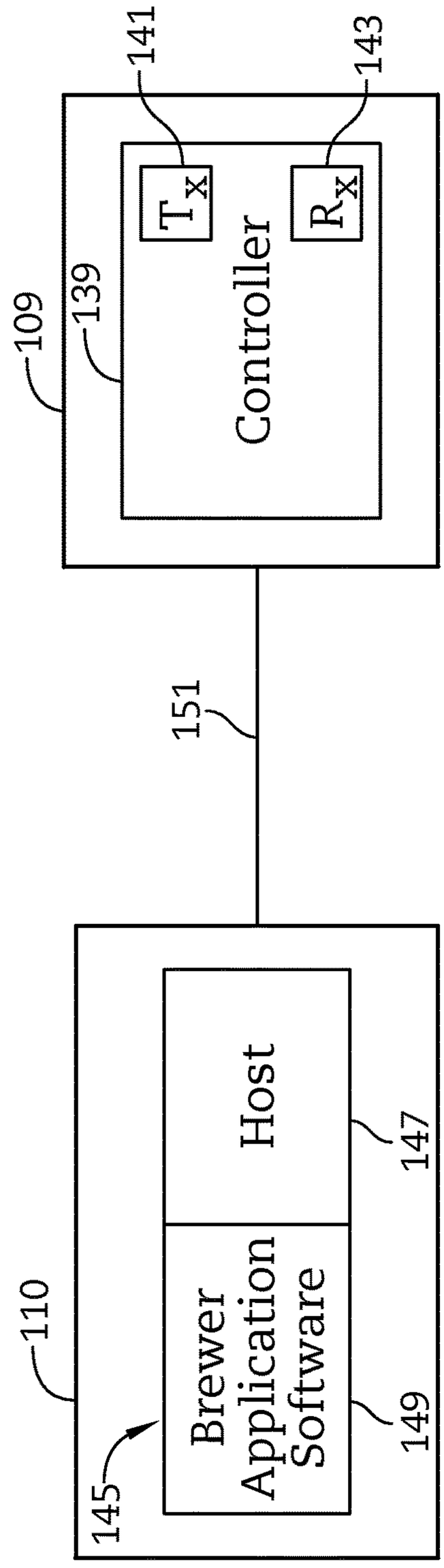
109
139
141
143
Tx
Rx
Controller
151
Host
147
110
145
Brewer Application Software
149

FIG. 2A

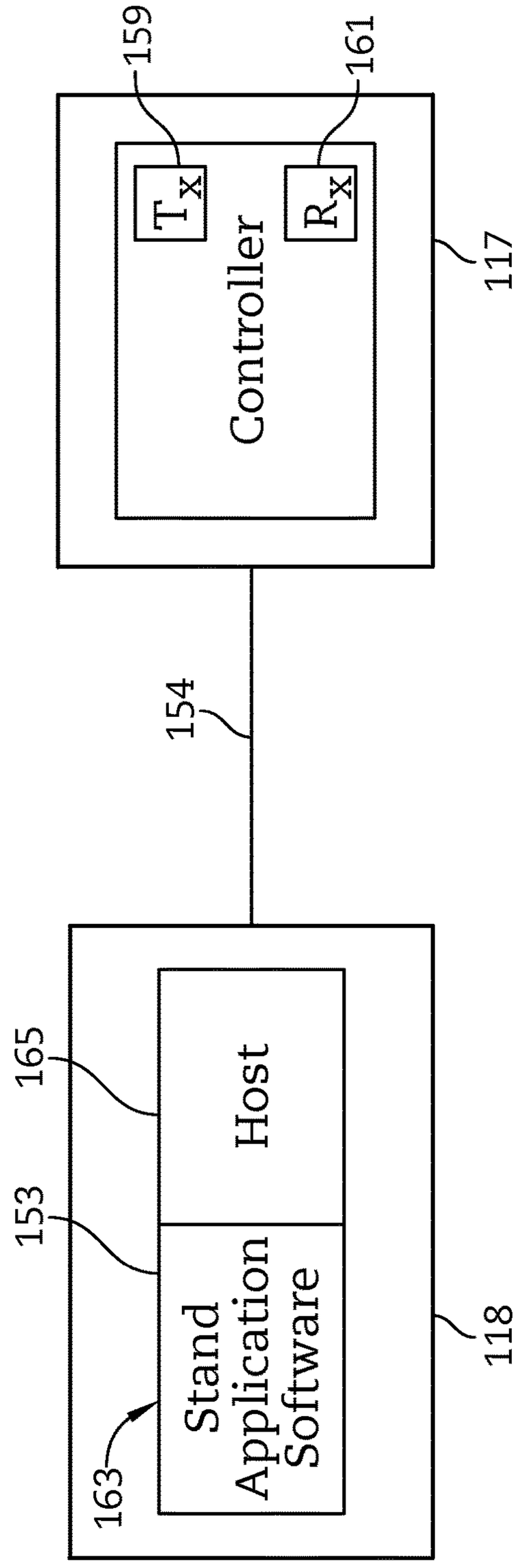
159
161
Tx
Rx
Controller
117
154
165
Host
153
163
Stand Application Software
118

FIG. 2B

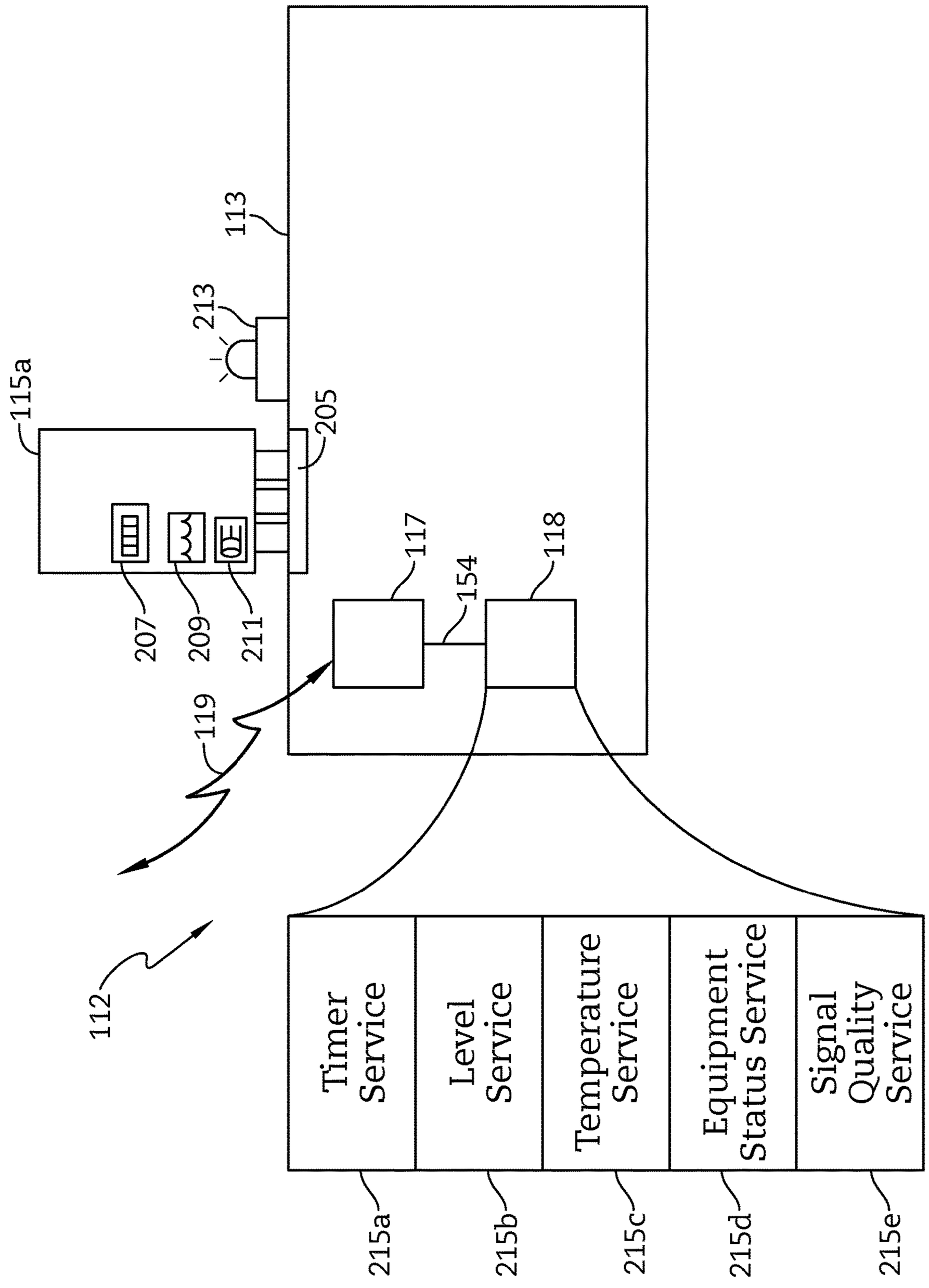
113
213
115a
205
207
209
211
117
154
118
119
112
Timer Service
Level Service
Temperature Service
Equipment Status Service
Signal Quality Service
215a
215b
215c
215d
215e

FIG. 3

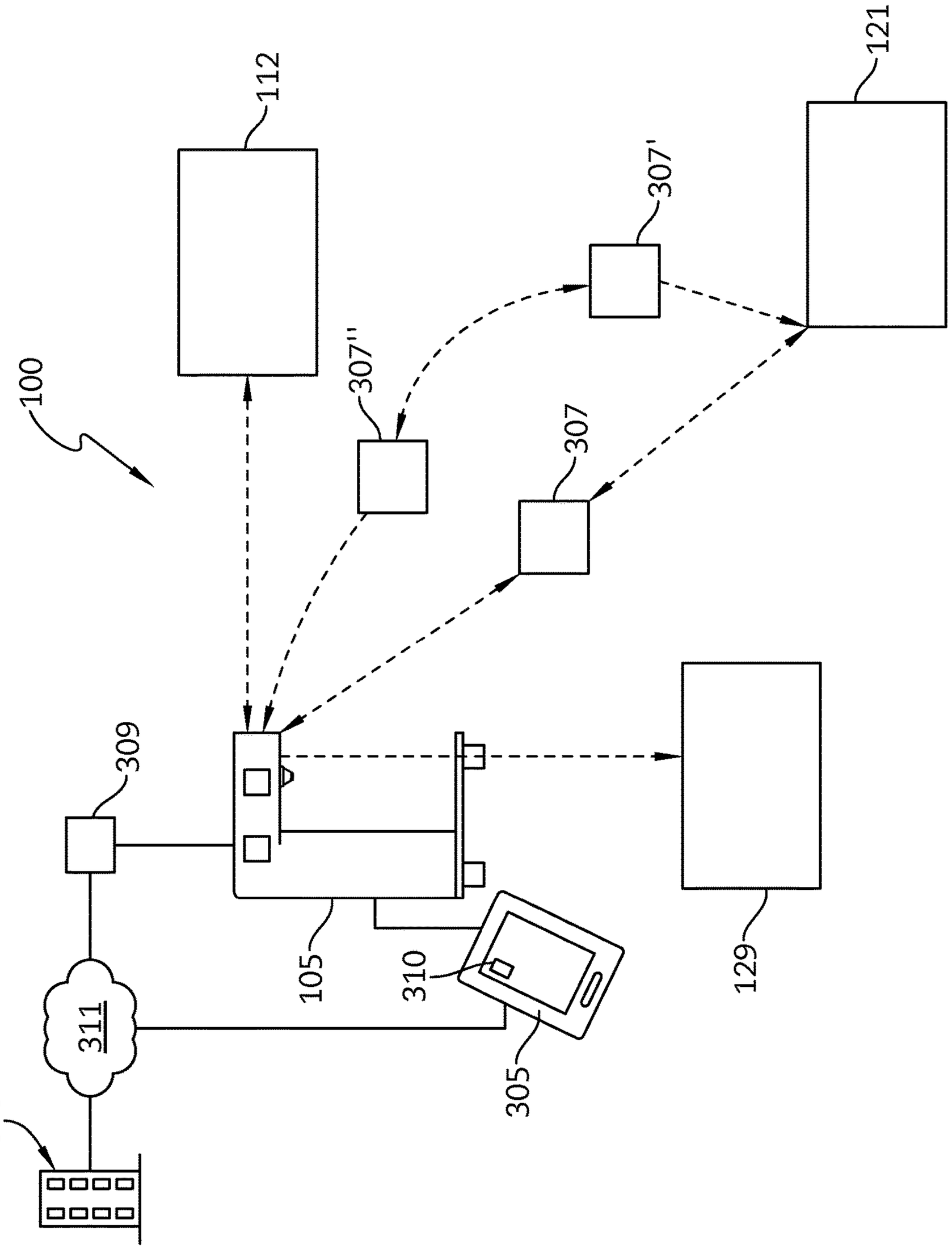

FIG. 4

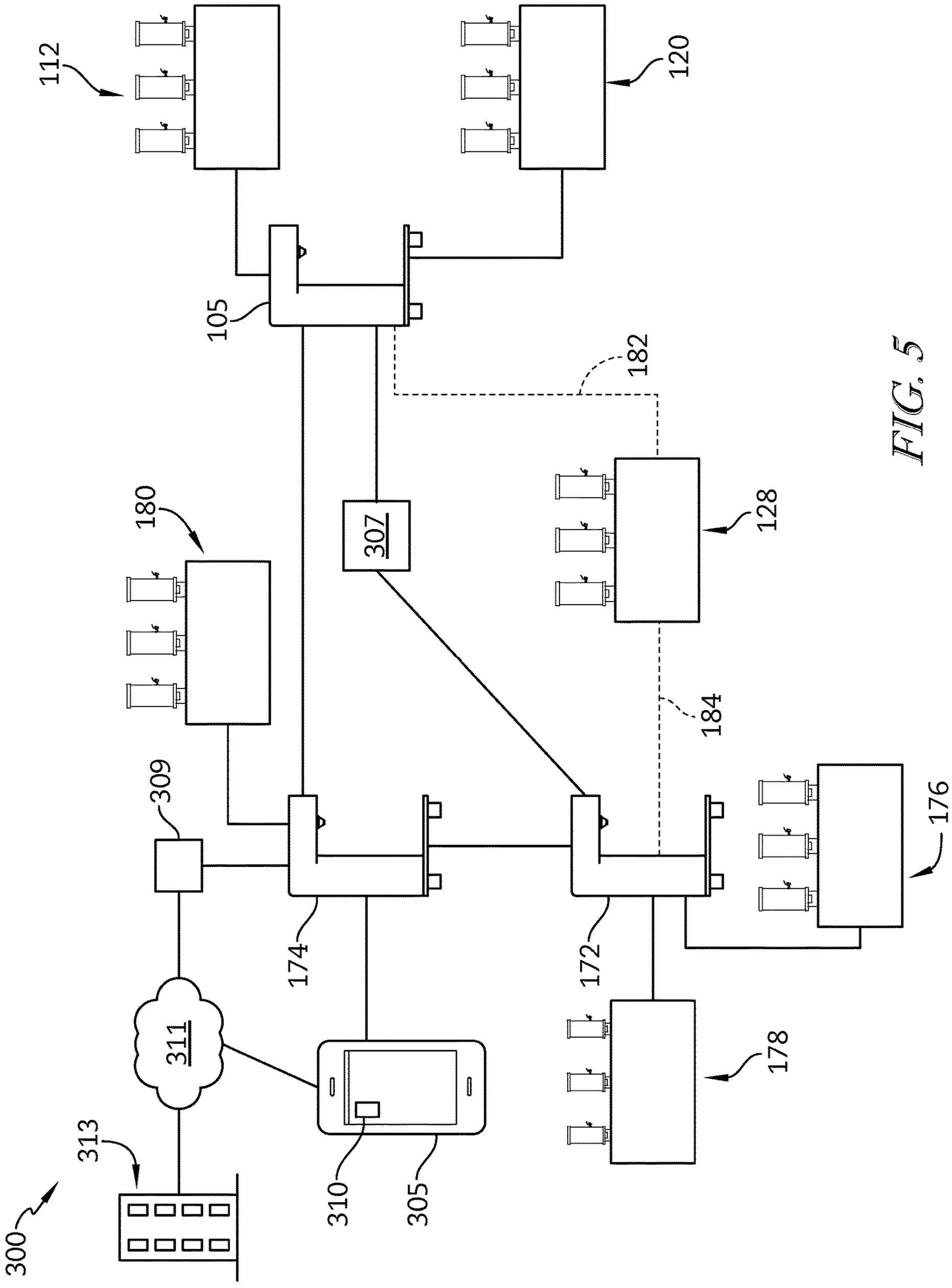
112
120
105
182
180
307
128
184
309
176
174
172
178
311
313
310
305
300

FIG. 5

BEVERAGE COMMUNICATIONS SYSTEM USING A COMMUNICATION PROTOCOL

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a U.S. nationalization under 35 U.S.C. § 371 of International Application No. PCT/US2015/026862, filed Apr. 21, 2015, which claims priority based upon U.S. Provisional Patent Application Ser. No. 61/981,881, filed Apr. 21, 2014, and entitled BEVERAGE COMMUNICATIONS SYSTEM USING A LOW ENERGY COMMUNICATION PROTOCOL, and also claims priority based upon U.S. Provisional Patent Application Ser. No. 61/986,980, filed May 1, 2014, and entitled BEVERAGE COMMUNICATIONS SYSTEM USING A LOW ENERGY COMMUNICATION PROTOCOL. The disclosures of each of which are hereby incorporated by reference in their entireties.

BACKGROUND

Restaurants, cafeterias, banquet halls, retail establishments, and hospitality environments often include beverage stations having multiple servers (i.e., beverage dispensers) from which customers or guests can obtain beverages. Over time, however, any given server may run out of the beverage that it was dispensing. Moreover, the beverage contained within the server may age and fall outside of a predetermined freshness range or drop below a predetermined temperature threshold.

One way to address these issues is by having an employee physically visit the serving stations and inspect each server to determine whether the server has gone empty, whether the beverage within the server is no longer fresh, whether the temperature of the beverage within the server requires adjustment, or to generally determine the status of the server, such as whether it is malfunctioning. However, requiring an employee to physically visit each serving station is inefficient and costly. Moreover, it does not provide real-time feedback on the status of the servers. For example, minutes or hours may pass before a human visits a server and realizes that it is empty or that its contents have gone stale. This could negatively impact product quality as well as the customer experience and customer satisfaction.

Accordingly, it would be desirable to develop improved systems, components, and methodologies for monitoring the status of servers using a communication network. It would further be desirable to provide systems, components, and methodologies by which instructions could be sent to the servers using the communication network that would cause the servers to modify their settings as to improve the quality of the beverage that the servers dispense. It would be desirable if the communication network offered reliable communications having suitable scalability, suitable range, suitable reliability, and suitable security.

This background information is provided to provide some information believed by the applicant to be of possible relevance to the present disclosure. No admission is intended, nor should such admission be inferred or construed, that any of the preceding information constitutes prior art against the present disclosure. Other aims, objects, advantages and features of the disclosure will become more apparent upon reading of the following non-restrictive description of specific embodiments thereof, given by way of example only with reference to the accompanying drawings.

SUMMARY

The present disclosure describes systems, components, and methodologies for providing a beverage communication network that allows for communication among brewer(s) and stands. Disclosed embodiments allow brewers and stands to communicate information about the status of servers that rest on the stands. In certain embodiments, the brewer(s) and stands communicate information related to beverage freshness, beverage levels, beverage temperatures, along with information about equipment status and the performance of communication links within the beverage communication network.

In certain disclosed embodiments, the information related to beverage freshness, beverage levels, beverage temperatures, and equipment status are monitored and, based on the monitoring and as appropriate, the beverage communication network causes lights or other indicators near servers to activate in order to indicate that the servers require attention.

In certain disclosed embodiments, the beverage communication network allows an on-site user or a remotely located user to monitor the status of the servers using a computing device that is in communication with the brewer(s). Disclosed embodiments also include multiple brewer systems, for which information regarding some or all of the brewers and/or some or all of the stands are shared among stands and brewers.

The beverage communication network may operate according to any suitable wired or wireless communication technology. In exemplary implementations, the beverage communication network operates according to communications standards provided by the Bluetooth SIG organization, the Wi-Fi organization, the ZigBee organization, the Z-wave organization, any of several IEEE wired and wireless networking specifications and/or the power line carrier specifications. According to certain aspects of the present disclosure, the use of a specific protocol can be chosen to provide robust, secure and economical communication means for a specific retail or hospitality environments, interference-mitigating features suitable for environments in which other wired or wireless networks may be operating nearby, and desirable security features.

Additional features of the present disclosure will become apparent to those skilled in the art upon consideration of illustrative embodiments exemplifying the best mode of carrying out the disclosure as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will be described hereafter with reference to the attached drawings which are given as non-limiting examples only, in which:

FIG. **1** is a diagrammatic illustration of a version of a beverage communication network having a brewer and serving stations;

FIG. **2**A is a block diagram depicting exemplary hardware and software components of a communication module and a control module provided on a brewer;

FIG. **2**B is a block diagram depicting exemplary hardware and software components of a communication module and a stand;

FIG. **3** is a more detailed view of a portion of the beverage communication network depicted in FIG. **1**, and shows

hardware and software components by which the beverage communication network allows for monitoring of beverage freshness, beverage levels, beverage temperatures, equipment status, and signal quality;

FIG. **4** is a diagrammatic illustration of another configuration of the beverage communication network shown in FIG. **1** that includes a computing device for monitoring and controlling the beverage communication network, repeaters for extending the range of the beverage communication network, and a gateway for connecting the beverage communication network to a corporate IT system; and

FIG. **5** is a diagrammatic illustration of another configuration of the beverage communication network in which multiple brewers and multiple serving stations are in networked communication and can exchange information both among themselves and with a computing device that monitors and controls the beverage communication network.

The exemplification set out herein illustrates embodiments of the disclosure that are not to be construed as limiting the scope of the disclosure in any manner. Additional features of the present disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of illustrative embodiments exemplifying the best mode of carrying out the disclosure as presently perceived.

DETAILED DESCRIPTION

While the present disclosure may be susceptible to embodiment in different forms, there is shown in the drawings, and herein will be described in detail, embodiments with the understanding that the present description is to be considered an exemplification of the principles of the disclosure. The disclosure is not limited in its application to the details of structure, function, construction, or the arrangement of components set forth in the following description or illustrated in the drawings. The disclosure is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of various phrases and terms is meant to encompass the items or functions identified and equivalents thereof as well as additional items or functions. Unless limited otherwise, various phrases, terms, and variations thereof herein are used broadly and encompass all variations of such phrases and terms. Furthermore, and as described in subsequent paragraphs, the specific configurations illustrated in the drawings are intended to exemplify embodiments of the disclosure. However, other alternative structures, functions, and configurations are possible which are considered to be within the teachings of the present disclosure. Furthermore, unless otherwise indicated, the term "or" is to be considered inclusive.

With reference to FIG. **1**, a beverage communication network **100** is shown. The beverage communication network **100** can be placed in any number of locations, but in certain embodiments, is located in a retail location at which beverages are distributed, such as a coffee shop, a convenience store, a fast food restaurant, a hotel, or the like. The beverage communication network **100** can be used in connection with any type of beverage, include coffee, tea, cocoa, ciders, juices, water, or other forms of beverage. Although exemplary beverage dispensing equipment is depicted in FIG. **1**, it should be understood that beverage communication network **100** can accommodate any beverage dispensing equipment, such as any beverage dispensing equipment distributed by BUNN-O-MATIC® Corp. of Springfield, Ill.

The beverage communication network **100** includes a brewer **105**, a first serving station **112**, a second serving station **120**, and a third serving station **128**. The first serving station **112** includes a stand **113** upon which rest three servers **115***a*, **115***b*, and **115***c*. Similarly, the second serving station **120** includes a stand **121** upon which rest three servers **123***a*, **123***b*, and **123***c*. Finally, the third serving station **128** includes a stand **129** upon which rest three servers **131***a*, **131***b*, and **131***c*.

By way of overview, the beverage communication network **100** allows the brewer **105** to communicate with the stands **113**, **121**, and **129** using a communication protocol. In illustrative embodiments, the communication protocol is a wireless networking protocol, such as the Bluetooth® Low Energy ("BLE") specification, although other wired or wireless communication protocols are within the scope of the present disclosure. The brewer **105** is able to collect information regarding the status of the servers **115***a-c*, **123***a-c*, and **131***a-c*, including information about the beverage freshness, beverage levels, and temperature of the beverages stored within the servers **115***a-c*, **123***a-c*, and **131***a-c*. Other information can also be transmitted on the beverage communication network **100**, including information about the status of the brewer **105** and the serving stations **112**, **120**, **128** (such as whether any equipment is malfunctioning) and information about the signal quality for communication links in the beverage communication network **100**.

This information may be used to provide visual indicators or other types of notifications to users when certain servers **115***a-c*, **123***a-c*, or **131***a-c* require attention, may allow a user to monitor the status of the servers **115***a-c*, **123***a-c*, and **131***a-c* using a separate computing device (not shown in FIG. **1**, but to be discussed in connection with FIG. **4**), and may allow a user to monitor whether communications are effectively being transmitted across the beverage communication network **100**.

In more detail with respect to FIG. **1**, the brewer **105** is shown in conjunction with a server **107**. In operation, the brewer **105** brews a beverage and dispenses the beverage into the server **107** through a dispensing element **106**. The server **107** is then transported to either the first serving station **112**, the second serving station **120**, or the third serving station **128**. After the brewer is placed at a serving station **112**, **120**, or **128**, a customer can dispense the beverage stored within the server **107** using a dispensing valve **108**.

In certain embodiments, when the brewer **105** fills the server **107** with a beverage, the brewer **105** records a timestamp using an internal clock (not shown) indicating a time at which it filled the server **107**. The brewer **105** stores the timestamp within its internal system memory (not shown in FIG. **1**, but to be discussed in connection with FIG. **2**). The brewer **105** may also record the type of beverage with which it filled the server **107** e.g., coffee versus tea, which type of coffee, whether the coffee was decaffeinated, which type of tea, etc.

Although this illustrative embodiment shows the beverage communication network **100** having three serving stations **112**, **120**, and **128**, in other illustrative embodiments, the beverage communication network **100** may include fewer or additional serving stations. Likewise, this illustrative embodiment shows each serving station **112**, **120**, and **128** having three servers (e.g., in the case of serving station **112**, servers **115***a*, **115***b*, and **115***c*), but in other illustrative embodiments, fewer servers or more servers may be pro-

vided. Additionally, this illustrative embodiment shows one brewer **105** but in other illustrative embodiments, the beverage communication network **100** may include more than one brewer. Generally, the number of servers and/or brewers allowed for in the beverage communication network **100** may be governed by the limits of the communication protocol governing the beverage communication network **100**. In the illustrative example where BLE is used, may devices may be supported and the disclosed embodiments can support correspondingly many servers. In certain embodiments, each serving station **112**, **120**, and **128** contains 32 servers.

The servers **115***a-c*, **123***a-c*, and **131***a-c* are placed on their respective stands **113**, **121**, and **129**. In certain embodiments, the servers **115***a-c*, **123***a-c*, and **131***a-c* are coupled to their respective stands **113**, **121**, and **129** with a mechanical connection that keeps the servers **115***a-c*, **123***a-c*, and **131***a-c* in place, and with a power connection that provides electrical power from the stands **113**, **121**, and **129** to the servers **115***a-c*, **123***a-c*, and **131***a-c*.

In order to allow for communications among the components of the beverage communication network **100**, certain components of the beverage communication network are provided with communication modules that allow communication according to a protocol. As explained, in illustrative embodiments the beverage communication network **100** may use communication modules implementing BLE to provide communications functionality. BLE technology, as an example, is suitable at least because it has low energy requirements, it is inexpensive to implement, it provides desirable security features, it provides scalability suitable for deployment of the communication network **100** in spaces requiring many serving stations, and it provides communication ranges suitable for deployment of the communication network **100** in retail locations having a variety of sizes.

Thus, the brewer **105** includes a communication module **109** that allows for transmission and reception of data through wireless signals **111**. The brewer **105** also includes a control module **110**, which controls the operation of the brewer **105** and communicates with the communication module **109**. Similarly, the stand **113** includes a communication module **117** and a control module **118** for transmission, reception, and processing of data through wireless signals **119**, the stand **121** includes a communication module **125** and a control module **126** for transmission, reception, and processing of data through wireless signals **127**, and the stand **129** includes a communication module **133** and a control module **134** for transmission, reception, and processing of data through wireless signals **135**.

FIG. **2**A shows a more detailed view of the communication module **109** and the control module **110** provided in the brewer **105**. As known in the art, there are a variety of ways to implement BLE functionality on a device, and any appropriate implementation methodology that provides BLE compliance will be suitable for the illustrative beverage communication network **100** implementing BLE technology. In this illustrative embodiment, the communication module **109** includes a communication controller **139**. Where communications are provided in accordance with BLE, the communication controller **139** implements the Physical Layer and Link Layer functionality of the BLE specification. The communication controller **139** may be implemented as a microcontroller or as a system on a chip ("SOC"). The communication controller **139** includes integrated radio components, including a transmitter **141** and receiver **143**. The communication controller **139** may include additional memory components, such as a RAM (not shown). Where the beverage communication network **100** provides communications using other types of wired or wireless protocols, the communication controller **139** may implement analogous functionality in accordance with those respective wired or wireless protocols.

The control module **110** includes a microcontroller **145** that executes program code. In one respect, the microcontroller **145** executes code associated with communication host software **147**. Where communications are provided in accordance with BLE, the microcontroller **145** includes software that implements the Logical Link Control and Adaptation Protocol (L2CAP) layer, the Attribute Protocol (ATT) layer, the Generic Attribute Profile (GATT) layer, the Security Manager Protocol (SMP) layer, and the Generic Access Profile (GAP) layer of the BLE specification. Where the beverage communication network **100** provides communications using other types of wired or wireless protocols, the microcontroller **145** may implement analogous functionality in accordance with those respective wired or wireless protocols.

The microcontroller **145** also executes code associated with brewer application software **149**, whose functionality will be discussed in more detail below. It should be understood that brewer application software **149** and/or communication host software **147** can be written in any suitable programming language for execution on a microcontroller, such as C or assembly, and then compiled for execution on the microcontroller **145**. The microcontroller **145** may include additional memory components, such as a RAM (not shown). Brewer application software **149** may communicate with communication host software **147** using any suitable inter-software communication capability (e.g., through API's exposed by communication host software **147**, through remote procedure calls between communication host software **147** and brewer application software **149**, etc.).

The specific communication functionality implemented on the communication module **109** on the one hand and the control module **110** on the other hand can be varied while staying within the scope of the present disclosure. By way of example, the full suite of functionality of the communication protocol stack could be provided on a single chip, two chips, or more than two chips. The chips could be microcontrollers or more fully functional systems-on-chips. While certain aspects of a communication protocol's functionality associated with lower layers of the communication protocol, such as the physical layer, will be implemented in hardware, other layers may be implemented in either hardware, software, or firmware.

The control module **110** and the communication module **109** can communicate using any suitable mechanism, but in this embodiment as an illustration but not a limitation, they communicate through a serial connection **151**. In certain embodiments, the control module **110** and the communication module **109** are provided on a common circuit board and the serial connection **151** takes the form of a serial bus. In other embodiments, the control module **110** and the communication module **109** are provided on separate circuit boards and connect through other signaling mechanisms, such as cabling.

In certain embodiments, the control module **110** supplies power (e.g., 5 volts DC) to the communication module **109**. In other embodiments, the control module **110** and the communication module **109** draw from a common power source (not shown).

FIG. **2**B shows a more detailed view of the exemplary communication module **117** and control module **118** provided in the stand **113**, but it should be understood that the

communication module **125** and the communication module **133** may be substantially the same as the communication module **117**, and that the control module **126** and the control module **134** may be substantially the same as the control module **118**.

The communication module **117** and control module **118** provided in the stand **113** may be similar to the communication module **109** and the control module **110** provided in the brewer **105**. Specifically, the communication module **117** may be similar to the communication module **109**, having a communication controller **157** that may be similar to the communication controller **139**, and a transmitter **159** and receiver **161** that may be similar to the transmitter **141** and the receiver **143**, respectively.

Likewise, the microcontroller **163** may be similar to the microcontroller **145** in that the communication module host **165** may be similar to the communication module host **147**. However, the microcontroller **163** will execute code associated with stand application software **153** rather than the brewer application software **149**. The functionality implemented by the stand application software **153** will be discussed in more detail below.

According to one aspect of illustrative embodiments of the present disclosure, the beverage communication network **100** may be implemented as a star or layered star network. When implemented using BLE, the brewer **105** operates as a BLE master in accordance with the BLE specification, and the stands **113**, **121**, and **129** operate as BLE slaves in accordance with the BLE specification. This arrangement allows the brewer **105** to operate as a central coordinator of communications among the brewer **105** and the stands **113**, **121**, and **129**. This arrangement is advantageous at least because it allows for the stands **113**, **121**, and **129** to consume less power than the brewer **105** in connection with BLE transmissions, and because it may allow for the stands **113**, **121**, and **129** to implement lower cost communication modules **117**, **125**, and **133** than the communication module **109** provided with the brewer **105**.

FIG. **3** shows a more detailed view of a portion of the serving station **112**, but it should be understood that serving stations **120** and **128** contain and use similar structures, components, and methodologies. When the beverage communication network **100** is implemented in accordance with BLE, the stand **113** operates as a BLE server to the brewer **105**, which acts as a BLE client. Thus, the stand **121** exposes several BLE services. In this illustrative embodiment, the stand **121** exposes a timer service **215***a*, a level service **125***b*, a temperature service **216***c*, an equipment status service **215**, and a signal quality service **215***e*. As depicted in FIG. **2**, software associated with the timer service **215***a*, the level service **125***b*, the temperature service **216***c*, the equipment status service **215***d*, and the signal quality service **215***e* may be executed in the control module **118**. In other embodiments, one or more of these services (e.g., the signal quality service **215***e*) may be implemented in the communication module **117**. The timer service **215***a* is used to communicate freshness information to the brewer **105**, the level service **215***b* is used to communicate beverage level information to the brewer **105**, the temperature service **215***c* is used to communicate temperature information to the brewer **105**, the equipment status service **215***d* is used to communicate the status of the serving station **112**, including whether any of its components are malfunctioning, and the signal quality service **215***e* is used to communicate information on the signal quality of wireless signals **119**.

To provide the timer services **215***a*, the server **115***a* includes a timer component **207**. The timer component **207** can measure absolute time of day (e.g., 4:05 PM), preferably to a resolution of at least minutes, and in certain embodiments to a resolution of seconds. The timer component **207** can also be a countdown timer that is set to a predetermined value when the brewer **105** fills the server **115***a* with a beverage, in which case the timer component **207** counts down until it reaches zero. The timer component **207** can also be a real time clock that counts up from a point in time when the beverage communication network **100** is reset.

To provide the level service **215***b*, the server **115***a* includes a level monitoring component **209**. The level monitoring component **209** can be any sensor capable of identifying information regarding how much beverage is contained within server **115***a* and/or whether the quantity of beverage is below a certain level in server **115***a*. By way of example, the level monitoring component **209** may be a conductivity sensor to detect the presence or absence of liquid that is mounted within the server **115***a* at a predetermined height or range of heights. A reading by the level monitoring component **209** of conductivity or a lack of conductivity indicates that the beverage level within the server **115***a* is outside of the threshold level at which the level monitoring component **209** detects the presence or absence of liquid.

To provide the temperature service **215***c*, the server **115***a* includes a temperature sensor **211**. Any temperature sensor capable of measuring the temperature of beverages will be suitable, and preferably the temperature sensor **211** will have a thermal range and sensitivity suitable for use with hot beverages. In certain embodiments, a thermistor is used to measure temperature changes.

To provide the equipment status service **215***d*, the server **115***a* may communicate status indicators to the control module **118**. For example, a separate status signal may be issued for various components of the server **115***a*, including its power source and delivery mechanisms, its internal circuitry, its dispensing mechanisms, its heating element **205**, or any other hardware or software component. If the status indicators to the control module **118** indicate that any component is malfunctioning, or if the control module **118** fails to receive a status indicator for any component, the control module **118** may conclude that the component is malfunctioning. These status indicators may be made available to the equipment status service **215***d*.

To provide the signal quality service **215***e*, the receiver **143** may measure signal quality of the received signal **119**. For example, the receiver **143** may measure the signal-to-noise ratio of the received signal **119** and communicate that measurement to the control module **118**. These measurements may be made available to the signal quality service **215***e*.

When beverage communication network **100** is implemented in accordance with BLE, the brewer **105** may act as a BLE client and send periodic requests to the stands **113**, **121**, or **129** seeking one or more of the timing information from the timer service **215***a*, beverage level information from the level service **215***b*, temperature information from the temperature service **215***c*, equipment status information from the equipment status service **215***d*, and/or signal quality information from the signal quality service **215***e*. To do so, by way of example with reference to the stand **113**, the communication module **109** of the brewer **105** establishes a BLE connection with the communication module **117** of the stand **113** in accordance with BLE specifications. Then, the brewer application software **149** sends a request via the communication host **147** specifying the service **215***a*, **215***b*, **215***c*, **215***d*, or **215***e* from which the brewer **105** seeks

information. The communication host **147** processes the request in accordance with BLE specifications and sends the request to the communication module **109** of the brewer **105** via serial link **151**. The communication module **109** transmits the request over radio signals **111**, which is received by the communication module **117** via radio signals **119**.

After receipt, the request is sent to the communication host **165** for processing in accordance with the BLE specification, and is then transmitted to the stand application software **153**. The stand application software **153** obtains the requested information from the timer component **207**, the level monitoring component **209**, the temperature sensor **211**, or the control module **118**, as appropriate. Specifically, the timer component **207** may send time information—e.g., the time of day, an indication that a timer has expired, etc.—to the stand application software **153**. The level monitoring component **209** may send information about the beverage level and/or indications of whether the contents of server **115***a* have fallen below a certain level to the stand application software **153**. The temperature sensor **211** may send temperature readings to the stand application software **153**. The control module **118** may send information regarding equipment status and/or signal quality to the stand application software **153**.

After the requested information is communicated to the stand application software **153**, it is sent to the communication host **165** for processing in accordance with BLE specifications, and then sent to the communication module **117** over the serial link **154**. The communication module **117** sends the information according to the BLE specifications through radio signals **119**. The information is received by the communication module **109** over radio signals **111**, and sent to the communication host **147**, which processes the received information according to BLE specifications and transmits the information to the brewer application software **149**.

Communications between the stand **113** and the server **115***a* can be provided by any number of wired or wireless communication mechanisms. In this illustrative embodiment, the server **115***a* does not have BLE functionality, and thus communicates to the control module **209** using other means. One version of exemplary systems, methods, and components for providing for communications from a beverage dispenser such as the server **115***a* are set forth in U.S. Pat. No. 7,268,698, the disclosure of which is incorporated by reference herein in its entirety. In other embodiments, the server **115***a* has BLE functionality and uses BLE communication protocols to transmit information to the communication module **117** of the stand **113**.

In the embodiment described above, the stand application software **153** solicits information from the timer component **207**, level monitoring component **209**, temperature sensor **211**, or information regarding equipment status and signal quality only upon request by the brewer **105**. As a result, communications only occur on an as-needed basis, providing for low power usage and lower interference. In other embodiments, the stand **113** communicates information periodically using BLE broadcasting functionality, without waiting for a prompt from the brewer **105**. The duration of the period between broadcasts will ordinarily be set by the brewer **105**, which as explained serves as a BLE master. The duration of the period may depend on which service **215***a*, **215***b*, **215***c*, **215***d*, or **215***e* is under consideration. For example, the brewer **105** may want information from the timer service **215***a* every 15 minutes, information from the level service **215***b* every 5 minutes, information from the temperature service **215***c* every 1 minute, information from the equipment status service every 5 minutes, and information from the signal quality service every second.

The embodiments described above are illustrative. It should be understood that any suitable mechanism in accordance with any suitable wired or wireless communication protocol, including those described above, can be used to communicate the above-described information to the brewer **105**.

As explained, upon receipt of timing information from the timer component **207**, the information is transmitted to the brewer application software **149** after being processed by the communication host **147**. The brewer application software **149** may determine whether the beverage contained within server **115***a* is still fresh. As explained earlier, the brewer **105** may have logged a times tamp when initially filling the server **115***a*. It may compare the timing information from the timer component **207** to the timestamp that it previously logged to compute how long the beverage within the server **115***a* has been sitting on the stand **113**. The brewer application software **149** may maintain look-up tables indicating the duration of time with which respective types of beverages stay fresh and may determine what type of beverage is contained within the server **115***a*. Based on this information, the brewer application software **149** may determine whether the beverage within the server **115***a* is still fresh.

If the brewer application software **149** determines that the beverage within the server **115***a* is not fresh, it may invoke a connection (e.g., a BLE connection) with the stand **113** in order to communicate to the stand **113** that the beverage within the server **115***a* is not fresh. The communication will be transmitted from the communication module **109** of the brewer **105** to the communication module **117** of the stand **113**, and will ultimately be received by the stand software application **153**. The stand application software **153** may be configured to activate a lighting element **213** (e.g., a light bulb, LED, etc.) to visually indicate that the server **115***a* requires attention. Upon seeing the visual indication, a human operator may visit the server **115***a* to refresh the beverage contained in the server **115***a*. Other notification types, such as audio notifications, are also within the scope of the present disclosure.

Upon receipt of the beverage level information from the level monitoring component **209**, the brewer application software **149** may determine that the server **115***a* is empty or requires a refill. Upon such a determination, the brewer application software **149** may send a communication to the stand **113** in accordance with the appropriate communications protocol (e.g., BLE) indicating that the server **115***a* must be refilled. The communication will be transmitted from the communication module **109** of the brewer **105** to the communication module **117** of the stand **113** and will ultimately be received by the stand software application **153**. The stand application software **153** may be configured to activate the lighting element **213** to visually indicate that the server **115***a* requires attention. Other notification types, such as audio notifications, are also within the scope of the present disclosure.

Upon receipt of the temperature information the temperature sensor **211**, the brewer application software **149** may determine that the server **115** is maintaining its beverage at an incorrect temperature. The brewer application software **149** may retrieve from system memory a look-up table reflecting the appropriate temperature for different types of beverages, and may also retrieve from system memory an indication of the type of beverage stored within the server **115**. The brewer **105** may then determine whether the temperature of the server **115***a* must be increased or

decreased. The brewer **105** then communicates its determination to the stand **113** in accordance with the appropriate communications protocol (e.g., BLE). The communication will be transmitted from the communication module **109** of the brewer **105** to the communication module **117** of the stand **113**, and will ultimately be received by the stand application software **153**. The stand application software **153** may be configured to activate the lighting element **213** to visually indicate that the server **115***a* requires attention. Other notification types, such as audio notifications, are also within the scope of the present disclosure.

Alternatively, the stand application software **153** may arrange for a heating element **205** to dissipate more or less heat, as appropriate, to adjust the temperature of the server **115***a*. Specifically, the server **115***a* is thermally coupled to the heating element **205**. The heating element **205** may be any component that dissipates variable heat in response to an input, such as a resistive heater. Although the heating element **205** is shown as part of the stand **113**, in other embodiments, the heating element **205** is provided within the server **115***a* but its power is provided by the stand **113**. The stand application software **153** can operate to increase or decrease the power driving the heating element **205** to either heat or cool the server **115***a*, as appropriate.

Upon receipt of equipment status information, the brewer application software **149** may determine that the server **115** requires attention in order to rectify equipment malfunctions. In this situation as well, appropriate communications may be transmitted from the communication module **109** of the brewer **105** to the communication module **117** of the stand **113**, and ultimately be received by the stand application software **153**. The stand application software **153** may be configured to activate the lighting element **213** to visually indicate that the server **115***a* requires attention. Other notification types, such as audio notifications, are also within the scope of the present disclosure.

Upon receipt of signal quality information, the brewer application software **149** may determine whether the serving station **112** is suffering from poor signal quality. The brewer application software **149** may communicate with other brewers (as will be explained below in connection with FIG. **5**), instructing the other brewers to determine whether the serving station **112** might experience improved signal quality from an alternate brewer. In response to such a determination, the serving station **112** may initiate communication with the alternate brewer. If the signal quality information indicates that the serving station **112** has lost connection entirely with the brewer **105**, the brewer application software **149** may initiate re-connection protocols with the serving station **112**. If the re-connection protocols fail, the brewer application software **149** may communicate with an alternate brewer, instructing the alternate brewer to attempt to establish a connection with the serving station **112**.

Although timing information, level information, temperature information, equipment status information, and signal quality information have been discussed in connection with the illustrative embodiment of FIG. **2**, the present disclosure contemplates that any other system parameters related to the server **115***a* and/or the stand **113** can be monitored, communicated, and/or approximated with the related signal communicated to the brewer **105**, and that the brewer **105** can communicate about any other system parameters or beverage characteristics to the stand **113**. By way of example, the server **115***a* can include a sensor that detects what type of beverage is contained within the server **115***a* and communicate that information over the beverage communication network **100**. By way of another example, the server **115***a* can include a sensor that detects the quantity or concentration of a particular ingredient, attribute, chemical, quality, etc., and communicate that information over the beverage communication network **100**. This allows the brewer application software **149** to determine whether the beverage within the server **115***a* is within a predetermined threshold or range, or outside of the threshold or range. According to another example, the server **115***a* can include a sensor that determines whether the beverage contained in the server **115***a* is decaffeinated. Information about these characteristics may be transmitted over the beverage communication network **100** in like manner as that described above in connection with the timer service **215***a*, the level service **215***b*, and the temperature service **215***c*.

In other embodiments, the servers **115***a-c*, **123***a-c*, and **131***a-c* communicate identifying information over the beverage communication network **100** that indicates to the brewer application software **149** which servers **115***a-c*, **123***a-c*, and **131***a-c* are at which respective location among the stands **113**, **121**, and **129**. This allows the brewer application software **149** to track and monitor the locations of the servers **115***a-c*, **123***a-c*, and **131***a-c*.

FIG. **4** shows certain alternative configurations for the beverage communication network **100**. In addition to the brewer **105**, the first serving station **112**, the second serving station **121**, and the third serving station **129**, the beverage communication network **100** also includes a computing device **305**, a repeater **307**, and a gateway **309**.

The computing device **305** is a tablet computer in this illustrative embodiment, but may also be implemented as a mobile smartphone, a PDA, a multimedia personal computer, a laptop, or any other similar, compatible, or substitutional device or system currently available or hereafter provided. The computing device **305** may include computer-readable media for carrying or having computer-executable instructions or data structures stored thereon. Such computer-readable media can be any available media that can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, such computer-readable media can comprise physical storage and/or memory media such as RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer. Computer-executable instructions comprise, for example, instructions and data which cause a general purpose computer, special purpose computer, or special purpose processing device to perform a certain function or group of functions.

The computing device **305** includes an operating system which may be selected from among Apple's iOS line of operating systems, the Android line of operating systems, the Windows Mobile or Windows Phone line of operating systems, BlackBerry operating systems, Linux Operating Systems or future evolution and implementation of device operating systems.

The brewer **105** can communicate with the computing device **305** in any number of ways, including any suitable wired or wireless communication protocol. In certain embodiments, the computing device may be Bluetooth®—or BLE-enabled and the brewer **105** can communicate with the computing device **305** using Bluetooth and/or BLE. In other embodiments, the brewer **105** and the computing device **305** may be 802.11 ("WiFi") enabled. In still other embodiments, the brewer **105** and the computing device **305**

may communicate through a USB connection. Other appropriate wired or wireless communication protocols are in accordance with the present disclosure.

The computing device **305** may include a software application **310** (indicated in FIG. **4** by way of an icon on the screen display of the computing device **305**) that presents a user with a graphical user interface showing a current status of the servers **115***a-c*, **123***a-c*, and **131***a-c*. The software application **310** may be of the type that is made available for download through application distribution platforms operated by the owner of a mobile operating system, such as the Apple App Store, Google Play, Windows Phone Store or BlackBerry App World. By way of example, the software application **310** may allow a user to observe a freshness level, a fill level, a temperature, an equipment status, and signal quality for each of the servers **115***a-c*, **123***a-c*, and **131***a-c*. The manner by which the brewer **105** can determine a freshness level, a fill level, a temperature, an equipment status, and a signal quality for each of the servers **115***a-c*, **123***a-c*, and **131***a-c* was described above in connection with FIG. **3**. A user can thus monitor the servers **115***a-c*, **123***a-c*, and **131***a-c* to determine whether any of the servers **115***a-c*, **123***a-c*, and **131***a-c* require attention.

FIG. **4** also shows a repeater **307**. In the configuration of the beverage communication network **100** shown in FIG. **4**, the serving station **121** is located out of communication range from the brewer **105**. BLE communications from the serving station **121** are transmitted to the repeater **307**, which transmits the BLE communications to the brewer **105**. Similarly, BLE communications from the brewer **105** intended for the serving station **121** are intercepted by the repeater **307** and retransmitted to the serving station **121**. The repeater **307** can be any BLE-enabled device. In other embodiments, for serving stations sufficiently out of range, BLE communications traverse through multiple repeaters similar to the repeater **307**, akin to a "daisy chain" of repeaters. This is shown in FIG. **4** with repeaters **307'** and **307"**, which show a "daisy chained" communication path from the serving station **121** to the brewer **105**.

In certain embodiments, the repeater **307** may be a computing device akin to the computing device **305**, and thus may be a "smart" repeater.

FIG. **4** also shows a gateway **309**. The gateway **309** is any Internet-enabled device that communicates to the broader Internet **311**, such as a network server. In certain embodiments, the gateway **309** may be Bluetooth- or BLE-enabled and the brewer **105** can communicate with the gateway **309** using Bluetooth and/or BLE. In other embodiments, the brewer **105** and the gateway **309** may be 802.11 ("WiFi") enabled and communicate using WiFi. In still other embodiments, the brewer **105** and the gateway **309** may communicate through a USB connection. Other appropriate wired or wireless communication protocols are in accordance with the present disclosure.

In certain embodiments, the gateway **309** is a computing device akin to the computing device **305**, which is also shown to connect to the Internet **311**. The computing device **305** can connect to the Internet **311** using any suitable mode of networking, such as an 802.11 "WiFi" connection or a 4G or other cell connection.

The brewer **105** transmits information about the servers **115***a-c*, **123***a-c*, and **131***a-c*, including information about freshness level, fill level, and temperature, to the gateway **309**. By doing so, any Internet-enabled computing device may access the information by querying the gateway **309**. In FIG. **4**, it is depicted that computing devices within an office building **313** (e.g., a corporate headquarters) can query the gateway **309** over the Internet **311** to obtain information about the servers **115***a-c*, **123***a-c*, and **131***a-c* in the retail location containing the beverage communication network **100**. This allows corporate managers to monitor and observe the status of the servers **115***a-c*, **123***a-c*, and **131***a-c*.

As explained, the beverage communication network **100** in illustrative embodiments includes components that communicate according to a low energy wireless networking protocol, such as BLE. Thus, in certain embodiments, the beverage communication network **100** operates in the 2.4 GHz Industrial Scientific Medical (ISM) frequency band. In certain embodiments, the beverage communication network **100** implements a protocol offering multiple frequency channels and providing adaptive frequency hopping, as to minimize interference with other wireless communication devices and/or networks in the vicinity of the beverage communication network **100**. By way of example, adaptive frequency hopping helps mitigate interference with wireless networks that may be operated by neighboring retail establishments.

In certain embodiments, the total quantity of data transmitted across the beverage communication network **100** is relatively low and is infrequent, making BLE or other low energy wireless communication protocols a suitable choice.

In certain embodiments, the range between the brewer **105** and a serving station **112**, **121**, or **129** can be a distance up to tens of meters or hundreds of meters, but this range can be extendible by repeaters, such as repeater **307**.

In certain embodiments, power is provided to the BLE modules through batteries, such as a CR2032 "button cell" battery.

In certain embodiments, the beverage communication network **100** is implemented with security features. To activate security features, the brewer **105** will pair with the stands **113**, **121**, and **129**. In accordance with the BLE specification, the pairing process involves the exchange of pairing request messages, pairing response messages, encrypting the communications link, and exchange of security keys. The pairing process may be a Secure Simple Pairing process. Generally, any and all security and privacy features offered by the BLE specification may be optionally used with the beverage communication network **100**.

FIG. **5** is a diagrammatic illustration of another configuration of a beverage communication network **300** in which multiple brewers **105**, **172**, **174** and multiple serving stations **112**, **120**, **128**, **176**, **178**, **180** are in networked communication and can exchange information both among themselves and with computing device **305** that monitors and controls the beverage communication network **300**. In this illustrative example, each of the brewers **105**, **172**, **174** maintains communications with a subset of the serving stations. For example, the brewer **105** maintains communications with the serving stations **112**, **120**, the brewer **172** maintains communications with the serving stations **176**, **178**, and the brewer **174** maintains communications with the serving station **180**. In this illustrative example, the brewers **105**, **172**, **174** also maintain communications with one another. Thus, each of the brewers **105**, **172**, **174** can share information amongst one another regarding all of the serving stations **112**, **120**, **128**, **176**, **178**, **180** in the beverage communication network **300**. In this example, the computing device is in direct communication only with the brewer **174**, but obtains information regarding all of the brewers **105**, **172**, **174** and all of the serving stations **112**, **120**, **128**, **176**, **178**, **180** due to the above-described network topology, which enables the brewer **174** to aggregate information

regarding all of the brewers **105**, **172**, **174** and all of the serving stations **112**, **120**, **128**, **176**, **178**, **180** in the beverage communication network **300**.

In illustrative embodiments, serving stations may connect to multiple brewers or to the brewer that provides the strongest signal quality. In this example, serving station **128** measures the signal quality of wireless connection **184** with the brewer **172** and the signal quality of wireless connection **182** with the brewer **105**, and compares the respective signal quality measurements. The serving station **128** may notify the brewer **105**, **172** for which the serving station **128** has highest measured signal quality, and the appropriate brewer **105**, **172** may then initiate a connection with the serving station **128**. Similarly, as explained above, when any of the serving stations **112**, **120**, **128**, **176**, **178**, **180** suffer from poor signal quality and/or disconnections, the serving stations **112**, **120**, **128**, **176**, **178**, **180** may query the brewers **105**, **172**, **174** to determine which of the brewers **105**, **172**, **174** will provide improved signal quality. The appropriate brewer **105**, **172**, **174** may initiate reconnection.

While the present disclosure describes various exemplary embodiments, the disclosure is not so limited. To the contrary, the disclosure is intended to cover various modifications, uses, adaptations, and equivalent arrangements based on the principles disclosed. Further, this application is intended to cover such departures from the present disclosure as come within at least the known or customary practice within the art to which it pertains. It is envisioned that those skilled in the art may devise various modifications and equivalent structures and functions without departing from the spirit and scope of the disclosure as recited in the following claims. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

The invention claimed is:

1. A beverage communication network, comprising:

one or more brewers for brewing a beverage into one or more servers;

one or more serving stations for dispensing the beverage from the one or more servers, wherein the one or more serving stations include one or more stands dimensioned to receive the one or more servers separate and remote from the one or more brewers; and

one or more of a beverage freshness monitor, a beverage level monitor, or a beverage temperature monitor coupled to each of the one or more serving stations, wherein one or more of the beverage freshness monitor, the beverage level monitor, or the beverage temperature monitor coupled with one or more server stations with a stand configured to receive a plurality of servers are configured to communicate with the plurality of servers on the stand to receive sensor data from each respective server of the plurality of servers regarding one or more of freshness, beverage level, or beverage temperature;

wherein the one or more brewers and the one or more serving stations are in networked communication in accordance with a wireless networking protocol to communicate one or more of freshness, beverage level, or beverage temperature of the plurality of servers between the one or more brewers and the one or more server stations.

2. The beverage communication network of claim **1**, wherein the wireless networking protocol is a Bluetooth® wireless networking protocol.

3. The beverage communication network of claim **2**, further comprising a mobile computing device and wherein the brewer and the mobile computing device are in networked communication with a second wireless networking protocol.

4. The beverage communication network of claim **3**, wherein the second wireless networking protocol is a Wi-Fi communication protocol.

5. The beverage communication network of claim **1**, wherein each of the one or more brewers includes

a communication module for transmitting and receiving wireless signals in accordance with the wireless networking protocol; and

a control module, in communication with the communication module, that includes brewer application software.

6. The beverage communication network of claim **1**, wherein each of the one or more serving stations includes:

a communication module for transmitting and receiving wireless signals in accordance with the wireless protocol; and

a control module that includes application software for controlling functionality of the one or more servers received by each of the one or more serving stations.

7. The beverage communication network of claim **6**, wherein the application software includes computer code stored on a memory module which, when executed on a processor, causes the one or more serving stations to:

process queries wirelessly received from at least one of the one or more brewers seeking information regarding one or more of beverage freshness, beverage levels, and beverage temperatures;

retrieve information responsive to the request; and

wirelessly transmit the retrieved information to the at least one of the one or more brewers.

8. The beverage communication network of claim **1**, wherein the one or more brewers comprises at least two brewers, and wherein the at least two brewers are in networked communication in accordance with the wireless networking protocol.

9. The beverage communication network of claim **1**, wherein each of the serving stations includes a signal quality monitor.

10. The beverage communication network of claim **1**, wherein each of the serving stations includes computer code stored on a memory module which, when executed on a processor, causes the serving stations to:

measure a first signal quality for communications received from a first brewer;

measure a second signal quality for communications received from a second brewer;

determine which of the first signal quality and the second signal quality is superior; and

select, as a master communication device, the brewer corresponding to the signal quality determined to be superior.

11. The beverage communication network of claim **1**, wherein

the one or more brewers and the one or more serving stations are in networked communication with a mobile computing device; and

the mobile computing device provides a user interface by which a user can monitor beverage level, beverage temperature, and beverage freshness of serving stations located throughout the beverage communication network.

12. The beverage communication network of claim **1**, further comprising:

a daisy chain of repeaters connecting the one or more brewers and the one or more serving stations in accordance with the wireless networking protocol; and

an Internet gateway for connecting the one or more brewers and the one or more serving stations to the Internet.

13. The beverage communication network of claim **1**, wherein a brewer of the one or more brewers operates as a master communication device and the one or more serving stations operate as slave communication devices.

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